EXPERIMENTAL INVESTIGATION OF LIGHT WEIGHT CONCRETE USING LIGHT WEIGHT AGGREGATE ON BEAMS

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ABSTRACT: Over thousand of years, by the time these materials were improved upon, combined with other materials and change into modern concrete. Now days, concrete are made by using Portland cement, coarse aggregates, fine aggregates and water. The performance characteristics of concrete can be observed with change according to the different forces that the concrete will need to resist. Time after time, lots of invention have been made to improve quality of concrete in the concrete technology. With the improvement of the superstructure size in the constructions can be reduce such as beam and column in modern construction, structural light weight concrete have been used because less dead load, durability and cost savings. This present research work mainly focusses on an investigation of the workability and strength properties of lightweight aggregates, particularly pumice aggregate, used in the production of concrete with (PA) which were substituted for conventional Hard Broken Stone (HBG) coarse aggregate. Through the use of lightweight aggregate (PA) in place of some of the coarse aggregate, the properties of a lightweight concrete using M20 have been concentrated in this experimental study. The project study with the special concrete such as light weight concrete by using pumice aggregate (natural aggregate). One of the vibrant disadvantages of nominal concrete having high dead load. This heavy Self weight will make it to extent an uneconomical structural material. Light weight concrete having low density, to increase the thermal insulation. The reduction in density produced by using pumice aggregate as a limited replacement of coarse aggregate in concrete. In this investigation an attempt has been made to compare the nominal concrete and lightweight concrete using grade M20. Lightweight concrete is made of Partial replacement of Coarse Aggregate with different ratios of Pumice aggregate ranging from 10%, 20%, and 30% respectively with each ratio comprising of Beams for the curing period of 7, 14 and 28 days. This project is intensive to find out the compression strength and split tensile strength of lightweight concrete. This Experiment is focused to determine the strength parameters of the newly designed concrete, to find the most favorable replacement from the above mentioned replacements and the results are compared with the conventional concrete to calculate the Favourable replacements with the above mentioned replacements.

KEYWORDS: Pumice aggregates, light weight material, strength.

1.INTRODUCTION

Natural resources including water, sand, gravel, and crushed rock, which are currently in increasingly scarce, are mostly consumed by the concrete industry. Concrete has significant compression and resistance characteristics. The use of normal weight aggregates, such as gravel and granite, has resulted in a decrease in natural rock deposits and their continued exploration could cause environmental harm and ecological imbalance. It is therefore absolutely essential to find a suitable replacement material for the coarse aggregates used in the production of concrete. Concrete, like stone, is an artificial substance used for a variety of structural purposes. Normal Weight Concrete (NWC) has a density of 2400 kg/m3.

Concrete with a mass per unit area of 500 to 2000 kg is known as LWC concrete LWC could refer to concrete made from pumice aggregate Structural light weight concrete is a most adaptable material in present developed construction. It has several advantages such as dead load lessening and thermal insulation is more. If walls and floorings are made with light weight concrete, it leads to economy of construction. The use of light weight concrete is gaining wide acceptance in building construction, obviously thanks to the considerable reduction in mass. Reduced dead load by using light weight aggregate results in reduction of earthquake damages to structures. The cement content may be a prominent think about the physical/mechanical and sturdiness properties of lightweight aggregate concretes.

The ancient developments of lightweight concrete employed by Romans were Grecian and Italian pumice which were locally available. Since that time there has been advanced in the production of lightweight concrete using either the natural lightweight aggregates such as pumice or the artificial lightweight aggregates. Pumice is one among the foremost is feasible to commonly occurring natural lightweight coarse aggregates used for the assembly of concrete. Pumice lightweight aggregate is a volcanic-origin natural aggregate of very low specific gravity.

Thoe pumice is used to describe porous solids produced from the solidified magma produced during eruption of volcanoes. The voids are formed due to the release of gases in the pumice as CA can be used to reduce the self-weight members, hence lowering the cost of heavier beam and column requirements, the quantity of reinforcing bar needed, and the foundation's bearing capacity.

2. SCOPE OF THE STUDY

- This study focuses on the development and evaluation of light weight concrete using pumice as a coarse aggregate. The aim is to investigate its comparison to conventional concrete.
- Assessing properties such as compressive strength, density, workability, and water absorption.
- Evaluating how pumice based light weight concrete performs relative to standard concrete in terms of weight reduction and strength.
- Identifying potential uses in structural and nonstructural components, particularly where reduced weight is beneficial.

3. OBJECTIVES

- To design and develop a light weight concrete mix incorporating pumice aggregate.
- To evaluate the physical properties of pumice aggregate and its suitability for concrete production.
- To compare the performance of pumice – based concrete with that of conventional concrete in terms of strength – to – weight ratio.

4. MATERIALS AND METHODOLOGY

4.1 MATERIALS

4.1.1 Cement

Cement is the critical binder that helps hold everything together. It is a powder made from calcined limestone and clay. Cement has two setting stages: initial setting (30-45 minutes) and final setting (6-10 hours). These times ensure sufficient working time and proper hardening for construction.

4.1.2 Water

Water reacts with cement to initiate a chemical reaction called hydration. The hydration reaction leads to the hardening and setting of the concrete. The appropriate water-to-cement ratio is crucial for achieving the desired strength and durability of the final product.

4.1.3 Aggregate

Aggregates, such as gravel, sand, crushed stone, or recycled materials, provide the bulk and stability to concrete.

4.1.4 Fine aggregate

Fine aggregate is the filler for the voids in the coarse aggregate one of the main Ingredient in concrete. Fine aggregate can hold moisture in three forms: surface, absorbed, or free water. This property impacts the water-cement ratio and workability. Fine aggregates should have a rounded or angular shape and smooth texture for better workability and bonding in concrete

4.1.5 Coarse aggregate

Coarse aggregates are typically used in coarser concrete mixes, while fine aggregates are used in finer mixes. Coarse aggregate is less expensive than cement. By forming a large part of the concrete volume, it reduces the overall cost of the mix. In pavements and other high-wear applications, coarse aggregate provides resistance to abrasion and impact, extending the service life of the structure.

4.1.6 Pumice Aggregate

pumice is a common rock of volcanic origin, light weight aggregate, which occurs in many parts the world, and returns its useful properties. It was first introduced by the Romans in the second century where 'The Pantheon' has been constructed using pumice.The specific gravity is 0.82. Its water absorption is as high as 55%since it is a highly porous material. Larger volume of concrete can be handled by lighter Equipment with less wear and tear.

Figure 1: Pumice Aggregate

4.2 METHODOLOGY

4.2.1 Concrete Mix Design

In the present study, M20 grade with nominal mix as per IS 456 – 2000 was used. Concrete mix proportion by weight for $1m^3$ and water cement ratio of 0.5. Table 1. Gives the mix used for study.

Table 1: Mix proportion

S.NO	Cement	Water	Fine aggregate	Coarse aggregate
Normal concrete	1	0.5	1.6	3.2
LWC	1	0.5	2.9	1.3

4.2.2 Casting and Testing

Pumice was added in concrete in step of (10%, 20%, 30%). The percentage of partially replacement are arrived with trial study using Pumice. For each percent of Pumice partially replacement as coarse aggregate, cubes, cylinders, beam were casted. Final strength of cubes, cylinders and beams are tested for 7days, 14days and 28 days curing. The average compressive strength, split Tensile strength and Flexural strength are then determined for each mix proportion and discussed in the result and discussion.

5.RESULT AND DISCUSSION

5.1 Test results of compressive test

The cube specimens are tested for compressive strength at the end of 7days, 14days and 28days.

$fc = P / A \quad N / mm^2$

The results of the compressive strength tests on concrete cubes are shown in Table 2(a) and Figure 2 (a)

Table 2(a): Test result of Compressive Strength

S.NO	Percentages replacement of Pumice Aggregate	Average Compressive Strength N/mm^2		
		7 Days	14 Days	28 Days
1	10%	14.65	18.59	22.54
2	20%	12.96	16.27	19.95
3	30%	12.72	15.05	18.03

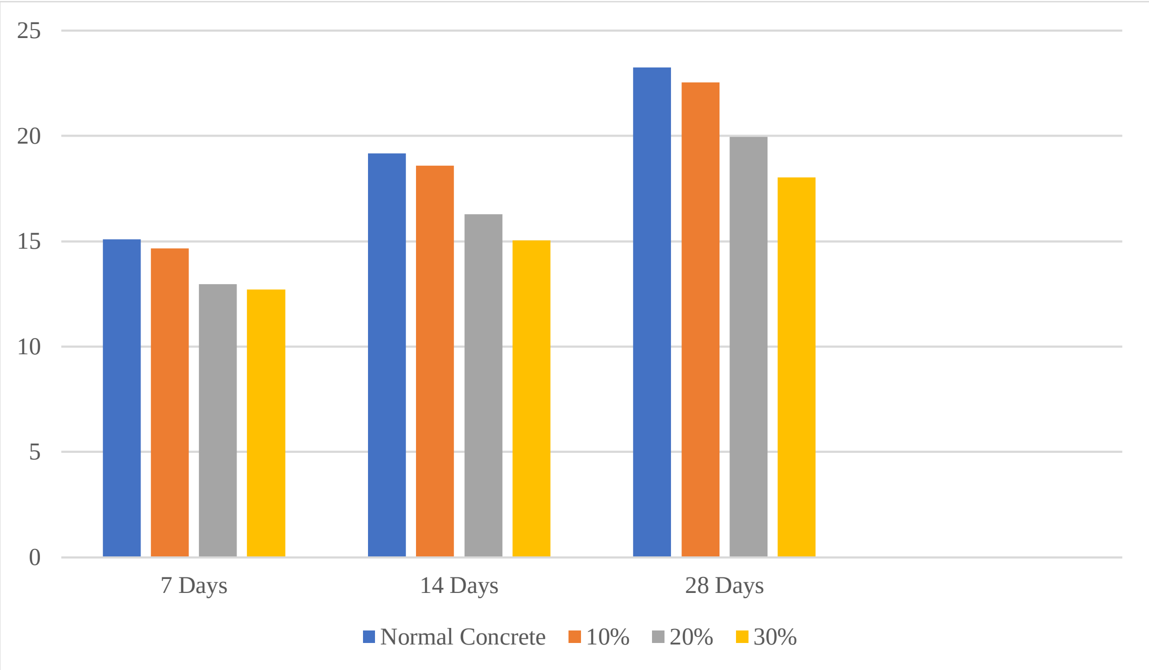

Figure: 2 comparison of compressive strength result

Figure: 2(a) Compressive Test

5.2 Test results of Split Tensile test

The cylinders specimens were tested for split tensile strength at the end of 7 days, 14 days and 28 days.

The split tensile strength of the specimen was calculated by using the formula fc = 2p /πdl

The results of the split tensile strength tests on concrete cylinders are shown in Table 2 (b) and Figure 3

Table 2(b): Test results of Split Tensile Strength

S.NO	Percentage replacement of Pumice Aggregate	Average Split Tensile Strength N/mm^2		
		7 Days	14 Days	28 Days
1	10%	1.57	2.0	2.43
2	20%	1.46	1.86	2.26
3	30%	1.07	1.36	1.65

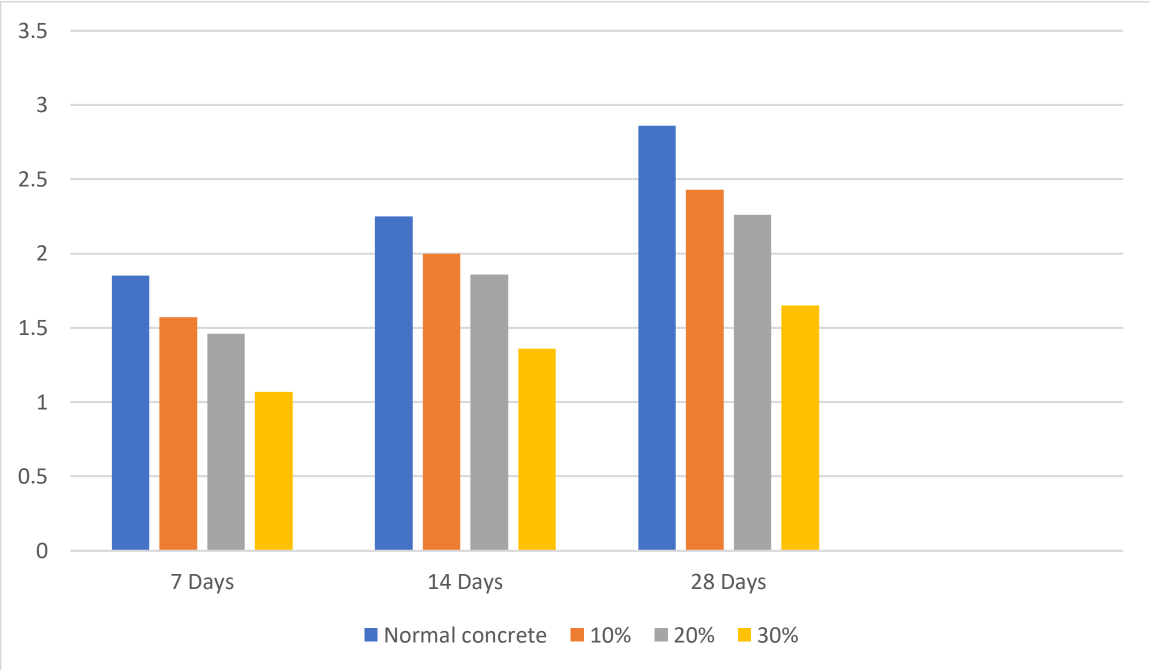

Figure 3: Comparison of split tensile result

Figure 3(a): Split Tensile Test

5.3 Test result of Flexural strength test

The beam specimens are tested for flexural strength at the end of 7 days, 14 days and 28 days.

The Flexural Strength of the specimen is calculated by

$Fb = Pl^2\ N/mm^2/bd$

The results of the Flexural strength tests on concrete beams are shown in Table 2(c) and Figure

Table 2(c) Test results of Flexural strength

S.NO	Percentage replacement of Pumice Aggregate	Average Flexural Strength N/mm^2		
		7 Days	14 Days	28 Days
1	10%	1.98	2.52	3.06
2	20%	1.93	2.45	2.97
3	30%	1.79	2.27	2.76

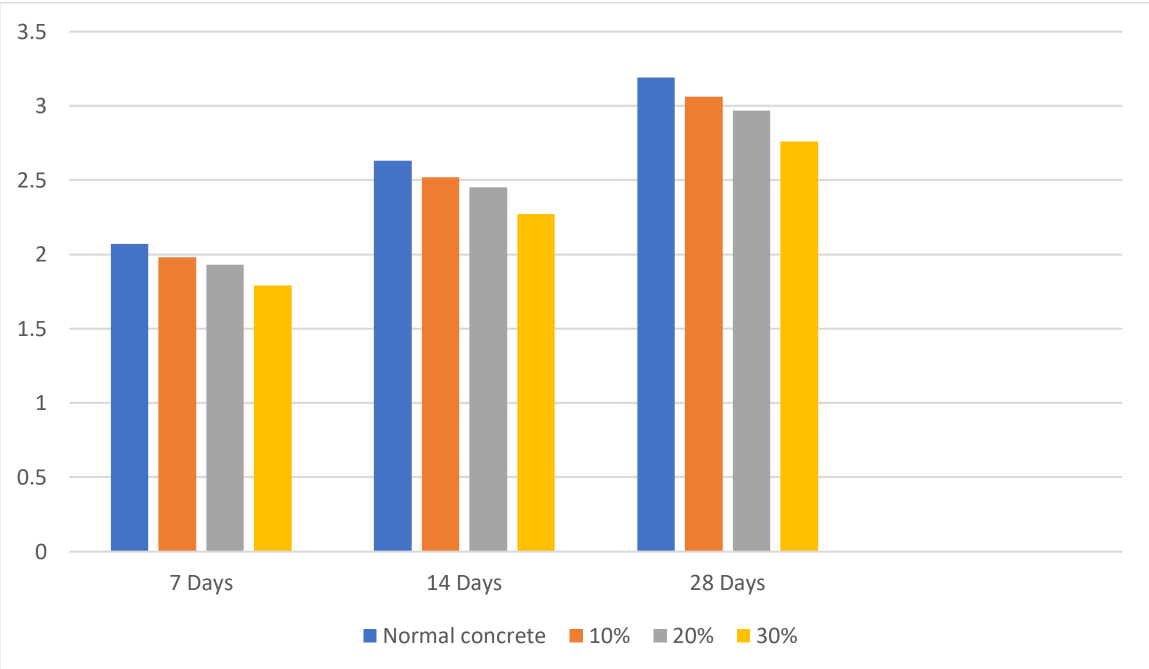

Figure 3: Comparison of flexural test

Figure 3(a): Flexural Test

6. CONCLUSION

- Pumice aggregate has been calculated and the required materials has been collected and their test for properties has been verified and tabulated.
- The compressive strength, split tensile and flexural strength of concrete with various percentage of Pumice aggregate is added with coarse aggregate are tested and the strength values show that partial replacement of coarse aggregate is permissible for M20 grade concrete.
- The Replacing percentages are 10%, 20%, 30% of Pumice aggregate.
- All above the test confirms that can partially replace the percentages with coarse aggregate so that can be could satisfy basic strength of M20 concrete for the above mix design.
- Hence the replacing the percentages are used for structural purposes such as floors, roofs, pavements and curtains walls.

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